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# Association of Obesity, Sarcopenia, and Functional Mobility with Risk of Fall: A Cross-Sectional Study from Ardakan Cohort Study on Aging (ACSA)

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## Abstract

**Background:** Falls are considered one of the leading causes of accidental deaths and nonfatal accidental injuries in older adults. Previous research indicates a 1-in-5 yearly fall incidence among Iranian older adults. To examine specific risk factors within this population, our study aimed to evaluate fall risk factors such as obesity, sarcopenia, functional mobility, and activities of daily living (ADL) scores.

**Methods:** This cross-sectional study used data from the first wave of the Ardakan Cohort Study on Aging (ACSA), involving participants >50 years who lived in Ardakan, Iran. The primary outcome was fall history in the past 12 months. The main biomechanical variables included body mass index (BMI), muscle strength, gait speed, static balance, and mobility-assisting devices. Sarcopenia was assessed based on the ratio of hand grip strength to BMI. Multiple logistic regressions assessed associations by odds ratio (OR) and 95% confidence interval.

**Results:** The final analysis included 4983 participants, 994 of whom reported at least 1 fall. Participants had a mean age of 62.21 ± 4.47 years (50-86 years), with a 48% male distribution. The results of multivariable logistic regression indicated that obesity (OR, 1.02 [95% CI, 0.70- 1.47]; *P* = 0.910), waist-to-hip ratio (OR, 1.02 [95% CI, 0.74-1.40]; *P* = 0.903), hand grip strength (OR, 1.20 [95% CI, 0.87-1.66]; *P* = 0.255), and sarcopenia (OR, 1.11 [95% CI, 0.82- 1.51]; *P* = 0.474) did not have significant associations with falls. However, impaired standing balance test (OR: 1.64 [95% CI, 1.09-2.47]; *P* = 0.017) and dependency on ADL (OR, 1.94 [95% CI, 1.05-3.56]; *P* = 0.032) increased falling.

**Conclusion:** Impaired balance tests and dependency on ADL increase the risk of falls in older adults. However, obesity indicators, sarcopenia, and gait speed were not associated with the risk of falls.

**Keywords:** Obesity, Sarcopenia, Accidental falls, Orthogeriatrics

***Conflicts of Interest:*** *None declared*
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## Introduction

Falls are prominent threats to human health, especially to older adults, and they are predicted to increase as this population rises. The global fall prevalence in the older population is 26.5% (3). Falling may result in complications—including fractures, head injuries, and even death, exposing

***↑What is "already known" in this topic:***
Falls are a significant cause of harm among older adults. Preventing falls is crucial, and identifying risk factors for vulnerability is essential.

***→What this article adds:***
This study investigates the relationship between factors like obesity, muscle strength, sarcopenia, mobility, balance, and ADL score with falling in Iranian older adults.
Impaired balance and dependency on ADL increase fall, while obesity, sarcopenia, and gait speed are not associated.

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patients' families and society to huge expenses (4). Falls in older adults, while common, are not a normal part of aging. Since falls are preventable, identifying risk factors seems rational (5). In a systematic review of the Iranian population, falls were common among older adults, with a prevalence ranging from 13.5% to 20% (2). This underscores the significance of conducting studies on the risk factors associated with falls in this population.

Sociodemographic factors like age, sex, in addition to physical disability, using mobility assisting devices, and suffering from simultaneous medical conditions such as central nervous system-affecting diseases and vertigo have been discussed (3). Obesity is related to functional limitation and increases the fall risk by up to 1.5 (6). Also, patients with severe activities of daily living (ADL) limitation are about 30% more likely to experience falling (7). Furthermore, lower extremities' strength and balance are better among nonfallers (5).

Fall risk assessment is critical to healthcare providers' evaluation of older adults. It is a vital examination suitable for outpatient care, emergency departments, and hospital settings. Identifying fall risk factors has also garnered interest among healthcare policymakers, leading to the development of population-based fall risk assessments. Continuous efforts are underway to develop tests for evaluating each risk factor, particularly within specific populations. Given the high prevalence of falls among Iranian older adults (8), it is crucial to investigate commonly reported factors in other studies and biomechanical factors that have received less attention in previous research. To our knowledge, no study has examined the relationship between body composition, sarcopenia, functional mobility, ADL scores, and the risk of falling in a large population in Iran. To address this gap, we aimed to assess the association between biomechanical variables, obesity, muscle strength, sarcopenia, mobility, balance, and ADL score with falling among the Iranian older population.

## Methods

This study was approved by the Research Ethics Committee of the University of Social Welfare and Rehabilitation Sciences (Code No. IR.USWR.REC.1394.490), and participants were recruited after obtaining informed consent.

### *Study Design and Participants*

This cross-sectional study utilized data from the first wave of the Ardakan Cohort Study on Aging (ACSA). ACSA is a population-based study of people >50 years old who have been living in Ardakan for over a year, starting in 2020 (9). Ardakan comprises 10 health centers, and a census was conducted through these centers to obtain an identifiable sample. The sampling frame included all middle-aged and older adults within the health centers. The number of participants selected from each health center was proportionate to the population of >50 years covered by that specific center. Subsequently, a simple random sampling method was employed within each cluster. The first wave of data collection for the cohort was completed within 1.5 years. The exclusion criteria encompassed conditions previously diagnosed by a specialist, such as severe physical disabilities like quadriplegia, which impedes independent movement, severe cognitive impairment inhibiting effective communication, or blindness.

### *Data Collection and Measurements*

The data collection involved in-person visits of the participants. Demographic characteristics included sex and age. Primary variables were assessed in 4 aspects:

1. Body composition parameters, including Body mass index (BMI), waist circumference (WC), and waist-to-hip ratio (WHR).
2. Muscle strength by hand grip test, 30 seconds repeated chair stands test, and sarcopenia calculated by an established formula.
3. Functional mobility assessment by Timed Up-and-Go test (TUG) (10) And 4-meter walk test (4 MWT).
4. Static standing balance, including side-by-side, tandem, and semi-tandem tests.

The WC was defined as high if it was >97 cm in men and >85 cm in women. The WHR was considered high if it was >0.95 in men and >0.85 in women (11).

Hand grip strength test: Participants were asked to sit down, keep the elbow angle at 90°, and squeeze a dynamometer as much as possible for 2 seconds. The test is impaired if it is <26 in men and <16 in women.

Thirty seconds repeated chair stands test: Results were classified as below average, average, and above average according to the values adjusted by sex and age (5). Accomplishing the Timed Up and Go (TUG) test in >20 seconds was defined as impaired (12).

The 4-meter walk test (4 MWT): After wearing proper clothes and shoes, participants walk a 4-meter distance at their usual speed from a standing position from the start point and through the 4-meter hallway to the marked finish line. 4MWT was considered normal if the participants passed the test in 5 seconds or less (13). Static balance was assessed and interpreted after established protocols and cutoffs, utilizing 3 tests: side-by-side, semi-tandem, and tandem. Overall standing balance was deemed impaired if, during any of these 3 tests, the participant lost their balance in <10 seconds (14).

Sarcopenia (Grip-BMI ratio): According to the Foundation for the National Institutes of Health (FNIH) Sarcopenia Project guideline, sarcopenia was obtained by weaker hand grip strength test number divided by BMI (15). The result reported in $m^2$ was considered sarcopenia if it was <0.56 in women and <1 in men (16).

ADL: Participants were asked to answer a questionnaire comprising 6 domains regarding dressing, feeding, continence, transferring, bathing, and toileting dependency. Participants were classified into 4 groups based on the number of domains that were scored as dependent: independent, mildly dependent (dependent in one domain), moderately dependent (dependent in 2 domains), and severely dependent (dependent in at least 3 domains) (17).

In addition, with a self-expressed method, Parkinson's disease (PD), multiple sclerosis (18), stroke and epilepsy were recorded. Moreover, participants were asked if they



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had been diagnosed with osteoarthritis and if they had undergone a lower limb joint replacement. Accordingly, the participants were divided into 3 groups: a group with a history of osteoarthritis without a joint arthroplasty, a group with both osteoarthritis and arthroplasty and a group without osteoarthritis or arthroplasty. An episode of vertigo and dizziness in the past 12 months was also recorded. Lower extremities amputation at any level was assessed during the physical examination.

Participants were asked whether they used any mobility assisting devices and were separated into 4 groups: using a cane, walker, other devices, and no use of mobility assisting devices.

Falling was the primary outcome. Participants were asked whether they had experienced one or more falling events in the past 12 months.

### *Statistical Analysis*

Baseline characteristics were described using mean ± standard deviation for quantitative variables and number (percentage) for the qualitative variables. Independent t tests and chi-square tests were used to compare fallers and nonfallers. Logistic regression tests were employed to identify factors associated with falling, with all variables entering the univariable model. The prevalence of dependency in overall ADL and each item was assessed among both fallers and nonfallers, along with mean ADL scores for both groups. Each item and overall ADL dependency was examined for its association with falls. Results were expressed in odds ratio (OR) and 95% confidence interval (CI).

For adjusted multivariable regression, 2 models were employed. In the first model, BMI was the sole measure of obesity, excluding WHR to prevent duplication. Hand grip was included, while sarcopenia was omitted because it incorporated hand grip in its formula. Conversely, the second model included WHR and sarcopenia, excluding BMI and hand grip, because of their similar measurement of the same aspect.

In both models, adjustments were made for all other variables within the model, encompassing age, sex, repeated chair stands test, TUG test, 4-meter walk test, standing balance test, ADL scores, mobility assistive devices, and comorbidities.

All data analyses were performed using STATA Version 15, and the results were considered significant if P < 0.05.

## Results

### *Baseline Characteristics*

Including 4983 participants in the final analysis, the study featured participants with a mean age of 62.21 ± 4.47 years (ranging, 50-86 years), with 48% being men. Among the participants, 994 (19.94%) reported at least 1 fall, with a 1-year incidence risk of fall 19.94% (95% CI:, 18.86-21.07). Fallers had a mean age of 63.27 ± 8.15, with a 61% woman proportion, while nonfallers had a mean age of 62.02 ± 7.59 years, comprising 50% women.

Fallers demonstrated an increased demand for assistive mobility devices and a higher likelihood of comorbidities. Moreover, female sex, obesity, elevated waist circumference, high WHR, impaired TUG test, 4-meter walk test, 30-second repeated chair stands, and standing balance test were observed more frequently among fallers (*P* < 0.05).

*Table 1.* Baseline characteristics among fallers and non-fallers

| Variable | Non-fallers (n= 3989) | Fallers (n= 994) | *P*-value |
|---|---|---|---|
| Age (mean ± SD) | 62.02 ± 7.59 | 63.27 ± 8.15 | < 0.001 |
| Sex | | | |
| Male | 2003 (50.21) | 390 (39.24) | < 0.001 |
| BMI | | | |
| Underweight (<18.5) | 41 (1.15) | 6 (0.69) | 0.002 |
| Normal (18.5 - 24.9) | 816 (22.81) | 183 (21.16) | |
| Overweight (25 - 29.9) | 1523 (42.58) | 326 (37.69) | |
| Obese 1 (30 - 35) | 868 (24.27) | 247 (28.55) | |
| Obese 2 ( >35) | 329 (9.20) | 103 (11.91) | |
| Waist Circumference | | | |
| High | 2846 (75.91) | 746 (82.16) | < 0.001 |
| Waist-to-Hip Ratio | | | |
| High | 3017 (81.34) | 778 (87.02) | < 0.001 |
| Hand grip strength | | | |
| Low | 387 (15.42) | 98 (21.68) | 0.001 |
| Timed Up and Go test | | | |
| Impaired | 123 (3.12) | 60 (6.11) | < 0.001 |
| 4-Meter Walk Test | | | |
| Impaired | 1374 (34.85) | 509 (51.83) | < 0.001 |
| 30 seconds Repeated Chair Stands | | | |
| Under average | 2326 (66.70) | 692 (77.06) | < 0.001 |
| Average | 906 (25.98) | 163 (18.15) | |
| Above average | 255 (7.31) | 43 (4.79) | |
| Standing balance test | | | |
| Side by side (impaired) | 76 (1.93) | 49 (4.99) | < 0.001 |
| Semi-Tandem (impaired) | 154 (3.91) | 102 (10.39) | < 0.001 |
| Tandem (impaired) | 435 (11.03) | 227 (23.12) | < 0.001 |
| Overall (impaired) | 437 (11.08) | 228 (23.22) | < 0.001 |

Bold numbers indicate statistical significance (P <0.05); Quantitative values are presented as mean ± standard deviation; Qualitative values are presented as number (2); BMI: body mass index; MS: multiple sclerosis.



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*Table 1.* Continued

| Variable | Non-fallers (n= 3989) | Fallers (n= 994) | *P*-value |
|---|---|---|---|
| Sarcopenia (Grip to BMI ratio) | | | |
| Low | 422 (18.46) | 90 (22.67) | 0.049 |
| Mobility assisting devices | | | |
| No | 3164 (79.70) | 637 (64.15) | < 0.001 |
| Cane or walking stick | 263 (6.62) | 142 (14.30) | |
| Walker | 75 (1.89) | 44 (4.43) | |
| Others | 468 (11.79) | 170 (17.12) | |
| Osteoarthritis and arthroplasty | | | |
| No osteoarthritis and no arthroplasty | 2882 (74.13) | 589 (61.10) | < 0.001 |
| Osteoarthritis without arthroplasty | 960 (24.6) | 352 (36.51) | |
| Osteoarthritis with arthroplasty | 46 (1.18) | 23 (2.39) | |
| Lower limb amputation | | | |
| Yes | 3 (0.08) | 2 (0.21) | 0.264 |
| MS/ Epilepsy / Stroke / Parkinson | | | |
| Yes | 114 (2.90) | 64 (6.55) | < 0.001 |
| Vertigo/Dizziness | | | |
| Yes | 543 (13.84) | 246 (25.18) | < 0.001 |

*Table 2.* Prevalence of dependency in overall ADL and each item among fallers and non-fallers, along with mean ADL scores for both groups

| Variable | Non-fallers N (2) | Fallers N (2) | OR (95%CI) | P-value |
|---|---|---|---|---|
| ADL items | | | | |
| Dressing dependent | 49 (1.23) | 37 (3.72) | 3.11 (2.02 - 4.79) | <0.001 |
| Feeding dependent | 4 (0.10) | 5 (0.50) | 5.04 (1.35 - 18.79) | 0.02 |
| Continence dependent | 166 (4.16) | 106 (10.66) | 2.74 (2.13 - 3.54) | <0.001 |
| Transferring dependent | 3 (0.08) | 0 (0) | 0.57 (0.03 - 11.09) | 0.712 |
| Bathing dependent | 62 (1.56) | 36 (3.62) | 2.38 (1.57 - 3.61) | <0.001 |
| Toileting dependent | 6 (0.15) | 6 (0.60) | 4.03 (1.30 - 12.53) | 0.013 |
| Functional status | | | | |
| Independent | 3773 (94.66) | 863 (86.82) | Reference | |
| Mildly dependent[#] | 161 (4.04) | 92 (9.26) | 2.51(1.92-3.28) | <0.001 |
| Moderately dependent[##] | 33 (0.83) | 22 (2.21) | 2.93(1.70-5.05) | <0.001 |
| Severely dependent[###] | 19 (0.48) | 17 (1.71) | 3.93(2.04-7.60) | <0.001 |
| Mean ADL score | 5.92 ± 0.35 | 5.80 ± 0.56 | 1.78(1.51-2.04) | <0.001 |

Bold numbers indicate statistical significance (P <0.05); ADL: Activities of Daily Living, [#] dependent in one item, [##] dependent in two items, [###] dependent in at least three items.

Table 1 details the characteristics of the fallers and nonfallers.

Table 2 demonstrates results regarding ADL. The mean ADL score was 5.80 ± 0.56 for fallers and 5.92 ± 0.35 for nonfallers (*P* < 0.001). The frequency of dependent participants in 5 domains, including dressing, feeding, continence, bathing, and toileting, was significantly higher among fallers (*P* < 0.05). The overall functional capacity of nonfallers tends to be higher, as they are more independent (94.66% vs 86.82%; *P* < 0.05).

### Factors Associated Wth Falling

The results of logistic regression are demonstrated in Table 3. According to the univariable model, increased age, sex, WHR, impaired repeated chair stands, functional mobility, gait speed and standing balance test results, dependency according to ADL, using mobility assisting devices, and suffering comorbidities—including osteoarthritis, MS, PD, epilepsy, stroke, and episodes of dizziness or vertigo—were associated with falling (*P* < 0.05).

After adjusting for covariates, the impaired balance test increased, falling by 0.64 (*P* = 0.017) in the first model and 0.62 (*P* = 0.019) in the second model. The strongest association was found between using mobility assisting devices and falling, in which OR was 2.62 for the cane and 2.91 for the walker. Mild dependency increased the risk of falls in both models (OR, 1.88 [95% CI, 1.03 - 3.42] and OR, 1.94 [95% CI, 1.05- 3.56], respectively). P, MS, stroke, and epilepsy increase falling by 80% in both models (*P* < 0.05), and participants experiencing episodes of dizziness or vertigo have a 54% higher risk of falling (OR, 1.54 [95% CI, 1.10-2.17]).

Figure 1 demonstrates a forest plot of ORs for fall in 4 BMI categories. It shows that a higher BMI has a greater risk of falling. However, the differences were not statistically significant. Figure 2 is a scatter plot showing that the risk of fall increases as the sarcopenia index decreases in both sexes, but this was not statistically significant.

## Discussion

This study aimed to determine the association between biomechanical variables, obesity, muscle strength, sarcopenia, mobility, balance, and ADL score with falling. The findings reveal that the 1-year incidence risk of falls was about 20%. Impaired balance tests and dependency in ADL significantly increased fall risk.

### Obesity and Risk of Fall

Obesity was statistically more prevalent among the fallers, and increased WHR was associated with a higher risk of falls in univariate analysis. Likewise, prior studies reported the same pattern (19, 20).



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*Table 3.* Logistic regression of factors associated with fall

| Variable (reference) | Univariable | | Model 1 | | Model 2 | |
|---|---|---|---|---|---|---|
| | Odds Ratio (95% CI) | *P*-value | Adjusted OR* (95% CI) | *P*-value | Adjusted OR* (95% CI) | *P*-value |
| Age | 1.02 (1.01 - 1.02) | < 0.001 | 1.00 (0.98 - 1.02) | 0.810 | 1.00 (0.98 - 1.02) | 0.850 |
| Sex (female) | | | | | | |
| Male | 0.64 (0.55 - 0.73) | < 0.001 | 0.78 (0.59 - 1.04) | 0.094 | 0.81 (0.61 - 1.07) | 0.143 |
| BMI (normal) | | | | | | |
| Underweight | 0.65 (0.27 - 1.56) | 0.337 | | | 0.74 (0.21 - 2.60) | 0.649 |
| Overweight | 0.95 (0.78 -1.16) | 0.648 | | | 0.77 (0.55 - 1.07) | 0.120 |
| Obese 1 | 1.26 (1.02 - 1.57) | 0.029 | | | 1.02 (0.70 - 1.47) | 0.910 |
| Obese 2 | 1.39 (1.06 - 1.83) | 0.017 | | | 0.88 (0.51 - 1.50) | 0.646 |
| Waist to Hip Ratio (1) | | | | | | |
| High | 1.53 (1.24 - 1.90) | < 0.001 | 1.02 (0.74 - 1.40) | 0.903 | | |
| Grip strength (high) | | | | | | |
| Low | 1.51 (1.18 - 1.94) | 0.001 | | | 1.20 (0.87 - 1.66) | 0.255 |
| Sarcopenia (no) | | | | | | |
| Yes | 1.29 (1.01 - 1.67) | 0.049 | 1.11 (0.82 - 1.51) | 0.474 | | |
| Repeated Chair Stands (average) | | | | | | |
| Under average | 1.65 (1.37 - 1.99) | < 0.001 | 1.10 (0.82 - 1.47) | 0.509 | 1.08 (0.81 - 1.45) | 0.578 |
| Above average | 0.93 (0.65 - 1.34) | 0.727 | 1.15 (0.70 - 1.88) | 0.575 | 1.12 (0.69 - 1.84) | 0.628 |
| Timed Up and Go test (normal) | | | | | | |
| Impaired | 2.02 (1.47 - 2.77) | < 0.001 | 0.54 (0.19 - 1.49) | 0.236 | 0.51 (0.18 - 1.42) | 0.203 |
| 4-Meter Walk Test (normal) | | | | | | |
| Impaired | 2.01 (1.74 - 2.31) | < 0.001 | 1.20 (0.88 - 1.62) | 0.231 | 1.19 (0.88 - 1.62) | 0.240 |
| Standing balance test (normal) | | | | | | |
| Impaired | 2.42 (2.02 - 2.89) | < 0.001 | 1.64 (1.09 - 2.47) | 0.017 | 1.62 (1.08 - 2.45) | 0.019 |
| ADL (Independent) | | | | | | |
| Mild dependency | 2.49 (1.91 - 3.26) | < 0.001 | 1.88 (1.03 - 3.42) | 0.037 | 1.94 (1.05 - 3.56) | 0.032 |
| Moderate dependency | 2.91 (1.69 - 5.02) | < 0.001 | 3.03 (0.90 - 10.1) | 0.071 | 2.93 (0.87 - 9.84) | 0.081 |
| Severe dependency | 3.91 (2.02 - 7.55) | < 0.001 | 1.87 (0.26 - 13.35) | 0.531 | 1.78 (0.24 - 12.93) | 0.567 |
| Mobility assisting devices (no) | | | | | | |
| Cane | 2.68 (2.14 - 3.34) | < 0.001 | 2.62 (1.59 - 4.34) | < 0.001 | 2.58 (1.56 - 4.27) | < 0.001 |
| Walker | 2.91 (1.98 - 4.26) | < 0.001 | 2.87 (1.17 - 7.03) | 0.021 | 2.91 (1.18 - 7.15) | 0.019 |
| Others | 1.80 (1.48 - 2.19) | < 0.001 | 1.96 (1.37 - 2.79) | < 0.001 | 1.98 (1.39 - 2.83) | < 0.001 |
| Osteoarthritis and arthroplasty (normal) | | | | | | |
| Osteoarthritis without arthroplasty | | < 0.001 | 1.20 (0.89 - 1.61) | 0.215 | 1.19 (0.88 - 1.60) | 0.248 |
| Osteoarthritis with arthroplasty | 2.44 (1.47 - 4.06) | < 0.001 | 0.96 (0.31 - 2.94) | 0.952 | 0.97 (0.31 - 3.01) | 0.963 |
| MS/ Epilepsy / Stroke / Parkinson (no) | | | | | | |
| Yes | 2.34 (1.71 - 3.20) | < 0.001 | 1.80 (1.01 - 3.25) | 0.048 | 1.79 (1.03 - 3.24) | 0.049 |
| Vertigo/Dizziness (no) | | | | | | |
| Yes | 2.09 (1.76 - 2.48) | < 0.001 | 1.54 (1.10 - 2.17) | 0.011 | 1.54 (1.09 - 2.17) | 0.013 |

*OR adjusted for all covariates in the models; BMI: body mass index; MS: multiple sclerosis; ADL: Activities of Daily Living.

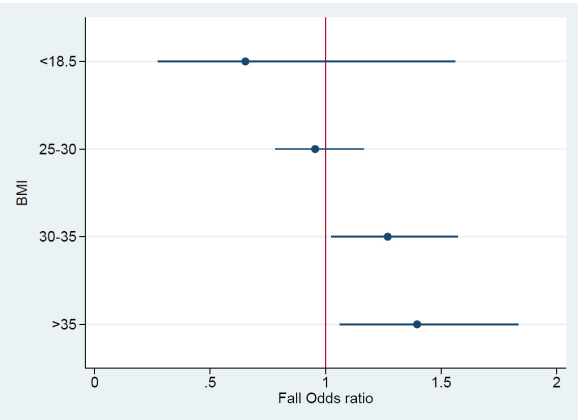


*Figure 1.* Forest plot showing odds ratio for each BMI category`

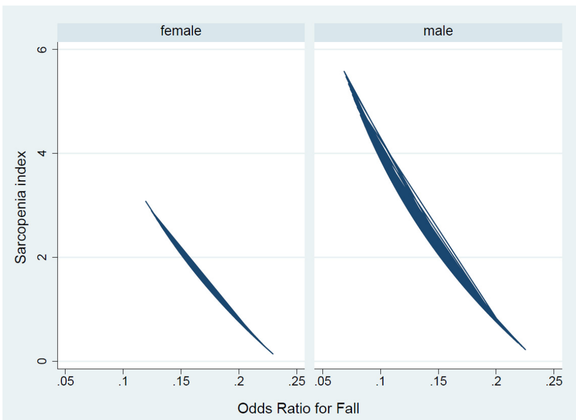


*Figure 2.* Association of FNIH defined sarcopenia and odds ratio of fall

However, after adjusting for other variables, we did not observe a statistically significant association.

The hypothesized effect of obesity on balance suggests that central obesity, coupled with a decline in lean muscle mass in older adults, may alter body weight distribution toward the trunk. This theoretically increases the likelihoo of falls with minor external forces. The results indicate that, upon adjusting the analysis with objective balance tests, the significant association between obesity and falls diminishes, further supporting this hypothesis. Additionally, it suggests that, in a clinical setting, rather than solely assessing obesity, evaluating patients with objective balance tests would be more effective in determining the risk of falls. Furthermore, the present study emphasizes the importance of concurrently examining confounding factors, as they may impact the independent effect of obesity on falls.

### Sarcopenia, Muscle Strength, and Risk of Falls

Sarcopenia leads to decreased muscle strength and impaired performance and may increase the risk of falling and fractures, as it occurs in older adults (21). However, a meta-analysis by Yeung et al reported that when sarcopenia was defined using the FNIH guideline, its association with falls was nonsignificant, although the positive relationship between sarcopenia and falling was confirmed using other approaches (22). Similarly, the present study revealed that sarcopenia, per the FNIH definition, exhibited no association with falls. This observation suggests that screening patients for sarcopenia using the FNIH formula and cut point. At the same time, potentially a convenient method for clinic assessment may not independently predict the risk of falls. Future studies should investigate alternative methods for identifying sarcopenia and evaluate their suitability for clinical settings.

In a community health survey conducted in a Taiwanese suburban area, 1067 older adults were retrospectively evaluated for 1-year fall episodes. The authors identified muscle strength, measured by the average grip strength of both hands, as the most significant factor (23). De Rekeneire et al found an association between an inability to do repeated chair stands and falling risk (24). One potential reason for this disparity could be attributed to the methodology employed. While previous studies utilized continuous quantitative variables for muscle strength analysis, we opted for a nominal qualitative representation of muscle strength. This approach offers a more practical perspective for clinicians and caregivers. Also, the observed differences may be attributed to adjustments made for other variables in the current study.

### Functional Mobility and Risk of Falls

The present study used 4MWT and TUG tests to assess gait speed and functional mobility. Some investigations oppose using the TUG test to predict falls because of its low sensitivity (25).

Nevertheless, considering the clinical applicability of these tests in Iran because of their simplicity, the present study aimed to assess the relationship between these 2 tests and falls in the Iranian population. AbuSamah et al concluded that while a decrease in gait speed among older adults may increase fall risk, the effectiveness of using gait speed to identify fall risk has not yet been established regarding discrimination and predictive validity (26). In our study, 4MWT and TUG tests were impaired more frequently in the fallers, but they were not considered significantly adequate in falling. This suggests that when accounting for other variables—including objective imbalance in patients, comorbidities, and vertigo and dizziness—the independent association of these tests with the risk of falls lost their significance. This raises concerns about relying solely on these tests for fall risk assessments in clinical settings.

Objective impaired balance increased fall risk by 1.6 in both groups. As people age, muscle strength, body reflexes, step length, and body size decrease, affecting their ability to maintain balance (27). Therefore, they may need to take extra steps to avoid falling (5). Consequently, those with higher gait balance disturbances are possibly more in danger (28). Muir et al found a similar relationship when evaluating participants over 75 and found that patients with balance disorders were at higher risk for falls (29).

Mobility-assisting devices were linked to a heightened risk of falling, approximately 2.5 times higher. Supporting this, a recent cross-sectional study reported that 87.6% of patients employing assistive devices experienced falls (18). Additionally, in another study involving patients with MS aged >45 years, a higher risk of falls was identified among those using mobility aids (30). This suggests that those with a history of falls may perceive a greater need to utilize mobility-assisting devices.

### Association of Falls and Dependency on ADL

The decline in functioning affects a person's musculoskeletal integrity and body composition, increasing falls, disability, and loss of independence. We found that participants with mild dependency on ADL had a 2- to 3-fold higher risk of falls than independent ones. Similarly, a recent study found a significant association between falling and ADL score (10). Multiple factors are involved in ADL, which can increase falling, as feeding and bathing dependency seemed important in predicting falls in a study in the United States (31). Severe dependency in ADL showed a lower association with falls compared with moderate dependency. This observation may be attributed to the fact that patients with severe dependency may receive assistance from others and reduce their activity, potentially resulting in lower levels of falling.

### Comorbidities Associated With Fall

A study of 1675 patients showed that osteoarthritis, with or without radiographic changes, increased the risk of falls in women (32). DoréAdam et al also reported a higher risk of falling up to 85% for those with 2 or 3 osteoarthritic joints (33). In our study, osteoarthritis did not affect falls. We adjusted the analyses with objective balance tests and other variables and found no significant association. This suggests that osteoarthritis may not independently be associated with an increased risk of falls, and other variables, particularly objective imbalance, may influence the observed associations. In addition, central nervous system-affecting diseases were associated with falling in this study. They affect patients' ability through their direct effect on their physical health and the indirect impact of their required medication, vertigo and dizziness increased, falling by 50%. Another study evaluating 2987 patients found a significant association between vertigo/dizziness and falls (34-37).

### *Strengths and Limitations*

While this study boasts strengths such as a substantial sample size, comprehensive inclusion of various variables, and a unique focus on the Iranian population, we acknowledge certain limitations. First, due to the ACSA exclusion criteria, participants with severe physical disability, dementia, and blindness were not included, potentially impacting the generalizability of our results, particularly to populations at higher risk of falls. Emphasis should be placed on interpreting the findings cautiously in this context. Second, given the cross-sectional nature of our study, data on falls and other variables were collected simultaneously. Longitudinal prospective studies are essential for a more robust determination of the causal relationship between falling risk and potential variables. These limitations should be considered when evaluating the overall validity and generalizability of the study findings.

## Conclusion

Impaired objective balance tests and dependency in ADL are associated with an increased risk of falls in adults >50 years, which could be considered by healthcare providers when assessing the fall risk in patients. On the other hand, specifying patients with obesity, impaired functional mobility, and sarcopenia based on commonly utilized tests did not seem to have an association with falls. This raises the need for further studies to develop the optimal tests for evaluating obesity, sarcopenia, and functional mobility when performing a fall risk assessment.

### *Authors' Contributions*

Conceptualization: Ahmad Delbari, Amirali Azimi, Mohammad Saatchi, Elham Hooshmand, Data collection: Amirali Azimi, Azin Pakmehr, Fatemeh-sadat Tabatabaei, Methodology: Mohammad Saatchi, Mohammad Bidkhori, Vahid Rashedi, Writing – original draft: Amirali Azimi, Azin Pakmehr, Fatemeh-sadat Tabatabaei, Elham Hooshmand, Review & editing: Ahmad Delbari, Mohammad Saatchi, Mohammad Bidkhori, Vahid Rashedi, Elham Hooshmand.

### *Ethical Considerations*

This study was approved by the Research Ethics Committee of the University of Social Welfare and Rehabilitation Sciences (Code No. IR.USWR.REC.1394.490), and participants were recruited after obtaining informed consent.

### *Acknowledgment*

Declared none.

### *Conflict of Interests*

The authors declare that they have no competing interests.

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